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# Cooperation in the horticultural supply chain: A 5-days field experiment

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## Abstract

Through a field experiment based on the prisoner's dilemma, we analyze the determinants of cooperative behavior in the horticultural sector, specifically on the effect of group membership. We focus on the Flowers for Bees Week initiative, a collective action in the supply chain (in particular producers and landscapers). We compare the behaviors of professionals in a repeated prisoner's dilemma game over 5 days, in two treatments: in-group (the players have the same role in the sector) and out-group (one player is a producer and the other a landscaper). The results are threefold. First, cooperation is higher in the in-group treatment compared to the out-group treatment. Second, when they cooperate, it is because they believe that the other will also cooperate. Lastly, the two sectors share the same views on collective actions and cooperation. We suggest levers to encourage collective actions in the sector.

## Keywords:

Cooperation; Field experiment; In-group Out-group effect; Horticulture; Prisoner's dilemma.

**JEL Classification : C93 ; D71 ; Q13**

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## 1. Introduction

Cooperation in agricultural supply chains is a key factor affecting the income of small and medium-sized farms, threatening their survival (Berti & Mulligan, 2016). This is particularly noticeable in the horticultural sector, who has a rather long and complex supply chain, with a large number of actors, including plant producers, landscapers and retailers.

Cooperation is defined as situations in which the activities and/or resources of some independent firms are pooled, and common problems are solved (Elomri, 2015). More concretely, cooperation is translated into the realization of collective actions. Strengthened cooperation between actors in the value chain, both horizontal and vertical, is likely to improve competitiveness (Brito et al., 2014; Grega, 2012). In the horticultural sector, cooperation made it possible to qualify horticultural products as essential products during the 2020 lockdown, therefore allowing the reopening of garden centers and horticultural nurseries. Enhanced cooperation between landscapers and producers could be a solution for producers to capture part of the added value, given their limited market power compared to retailers. Cooperation can reduce production or transaction costs, can contribute to market power, thus contributing to the competitiveness of horticulture (Grega, 2012). While economic actors are generally reluctant to take collective action (Hardin, 1971), there is evidence that the survival of an enterprise depends both on the aggressive pursuit of individual returns, but also on cooperation for the resolution of everyday problems of collective action (Ostrom, 2010). There is evidence that individuals cooperate even when it is individually costly (Fehr & Schmidt, 1999; Ledyard, 1995; Rand & Nowak, 2013).

But cooperation requires time. Previous literature on how to encourage cooperation in the sector (Ahmad et al., 2021; Musa et al., 2014; Richards et al., 2021) suggests that the actors of the sector cooperate but in a very temporary and selective way (Blondel & Noet, 2022). But long-lasting cooperation is necessary to have an impact on competitiveness (Axelrod, 1984; Axelrod & Dion, 1988; Elomri, 2015; Richards et al., 2021).

One of the levers envisaged to foster cooperation is to first encourage cooperation at the horizontal level (between producers of the same group). We investigate whether cooperation is fostered when individuals belong to the same group, and whether cooperation tends to fade when they are not. Previous evidence has shown that group identity is an effective way to promote cooperation within groups, since boundaries between self and others are blurred by group identity (Elsenbroich & Payette, 2020; Ockenfels & Werner, 2014; Rabinovich & Morton, 2011; Tajfel et al., 1971).

Based on a field experiment with professionals in the horticultural sector, we study the determinants of cooperation through a dual approach: a measure of stated preferences and the mobilization of a decontextualized strategic game. We

use the prisoner's dilemma as a framework for a two-person bargaining game to analyze cooperation. Referring to Mitani (2022), we focus on the role of group-identify, as a potential lever to foster cooperation. To do so, we compare cooperation level in groups where actors are matched in-group (landscaper with landscaper, or producer with producer) and out-group (producer with landscaper). The prisoner's dilemma is played over five days, from Monday to Friday, by reference to the flowers' week for bees.

The article is structured as follows. Section 2 further present the case under study: in-group and out-group cooperation in the horticultural sector and present the hypotheses to be tested in the experiment. Section 3 describes the experimental design. Results are presented in section 4 and section 5 concludes.

## **2. The case study: in-group/out-group cooperation in French horticultural sector**

### **2.1 Cooperation in horticulture**

The French horticultural sector is fragmented, complex, with many players. This sector covers the horticultural, floristry and landscape sector and represents almost 52,000 companies, 186,000 jobs and a turnover of 15 billion euros. It is divided into three major families: producers, retailers and landscape companies. Production includes horticultural plants, nursery, cut flowers and seeds. The retailers are constituted by garden centers, big retailers, florists, and specialized wholesalers. Finally, the landscape sector includes landscape companies and designers. All of them are represented by an inter-branch organization named Val'hor<sup>1</sup>, which is organized in ten unions representing the ten different branches of the horticultural chain. But the rate of French horticulturists belonging to a professional organization is considered low-medium (compared to 80% in Netherlands and 60% in Belgium and Germany, its three main competitors)<sup>2</sup>. This low representativity of the professional organization impacts the success of collective actions.

We focus on the example of “the week of flowers for bees”, initiated by Val'hor in partnership with the French Observatory of Apidology. It consists in a week, in June each year, to raise citizens' awareness on the role of melliferous plants, with also purchasing opportunities. This collective action can contribute to biodiversity, reducing the disappearance of pollinating insects<sup>3</sup>. A communication kit is available to actors willing to participate in the week of flowers for bees. However, since the first edition in 2017, only 5000 out of 52000 companies are involved. Yet, by highlighting the importance of plants, this operation can provide

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<sup>1</sup> the interprofession is the single one of the horticultural sector and brings together the ten unions of the sector: producers, retailers, and landscapers.

<sup>2</sup> <https://www.franceagrimer.fr/fam/content/download/69449/document/SYN-HOR-2022-VEILLE%20HORTICULTURE-2020.pdf?version=1>

<sup>3</sup> [https://www.ecologie.gouv.fr/sites/default/files/strategie%20Biodiversité%202030\\_1er%20volet.pdf](https://www.ecologie.gouv.fr/sites/default/files/strategie%20Biodiversité%202030_1er%20volet.pdf)

both private benefits (sales during this week), and social ones (biodiversity conservation in the long run).

## 2.2 Hypotheses

Our first hypothesis (H1) is that there is more cooperation in-group (landscapers with landscapers or producers with producers) than out-group (landscapers with producers).

Our second hypothesis (H2) is that subjects are more likely to sustain cooperation when they are in-group than out-group.

Finally, we investigate whether attitudes towards the issues at stake, like Flowers for Bees Week initiative, can explain cooperation levels.

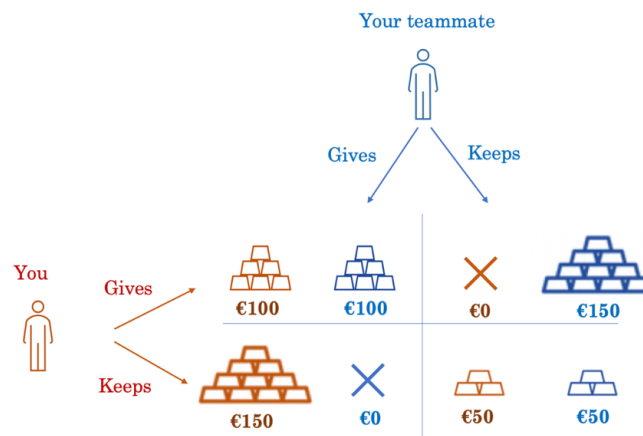
## 3. Experimental design

### 3.1 Game and experimental design

We rely on a lightly contextualized field experiment based on the prisoner dilemma game. Among the different games used to study cooperation (dictator game, trust game, faith game, stag hunt game) (Balliet et al., 2014), it best reflects our field reality. In discussions of environmental preservation, the prisoner's dilemma appears as a standard. It is used to address problems when agents make decisions about how to use common resources or public goods (Diekert, 2012), and to model bargaining games through a two-to-two structure (Madani, 2013):

The prisoner's dilemma game is presented as follows to the participants: Each subject starts with €50. The player can keep it or give it to the other player. When he gives the €50, the sum is multiplied by two and the other player receives €100. Therefore, if both players make the same decision, they both win €50, if they keep it and €100 if they give it away. If one player is the only one to donate, he wins nothing and the other has €150 (€50 kept and €100 received). At the time of the decision, the game was represented in a table summarizing all possible outcomes (figure 1a).

Figure 1a. Prisoner's dilemma game



The design includes 3 treatments related to how participants are matched in pairs, based on their self-declared type: P-P: producers are matched with producers; L-L: landscapers are matched with landscapers; P-L: Producers are matched with landscapers. The difference in cooperation level in PD game across these three treatments allow us to address H1. The game was repeated 5 times to address H2. The design and hypotheses have been pre-registered<sup>4</sup>.

Participants were incentivized through participation to a lottery to win vouchers allowing to purchase common products in many stores. Under the control of a financial manager, a random draw has selected four pairs of players<sup>5</sup>. Then, one out of the five days were also randomly picked to determine the value of the prizes, which will be ranging from 50 to 150 euros. With this random lottery incentives system (Voslinsky & Azar, 2021), we can consider that participants treat each decision in isolation.

### 3.2 Survey administration

The experiment was administered on-line (with LimeSurvey for part 1 and a software created with oTree for part 2 (Chen et al., 2016)). Part 1 includes questions to characterize the respondents' profile and attitudes, as well as their opinions on the week of flowers for bees, on their motivations and perceived barriers to collective action. They were then invited to take part in Part 2 corresponding to a repeated prisoner's dilemma game, played over 5 days. Each decision took no more than two minutes and could be taken any time between 2 am and 11 pm. On the first day, each subject indicated his or her decision in a prisoner's dilemma game and what he or she thought the other would do (give/take/don't know). For the next four days, each subject played with the same teammate and learned prior to the decision about the other player's previous decision and thus about his or her gain and the other's gain (Figure 1b represents the 4 possibilities each received before playing the next day).

While important actors of the horticultural sector<sup>6</sup>, retailers have not been included in the experiment. Even if the number of retailers remains very significant (18000 companies over the 52000 of the sector), the retailing is very concentrated. Retailers are thus less numerous and have more market power (Herzberg et al., 2022; Kopp & Sexton, 2021; Richards et al., 2021; Sexton, 2013). Unlike producers and landscapers, retailers are clustered around very large central purchasing or belong to large groups<sup>7</sup>. Their behavior differs from producers or landscapers, who are mostly in microenterprise structures. Their

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<sup>4</sup> [https://aspredicted.org/K7Z\\_KXB](https://aspredicted.org/K7Z_KXB)

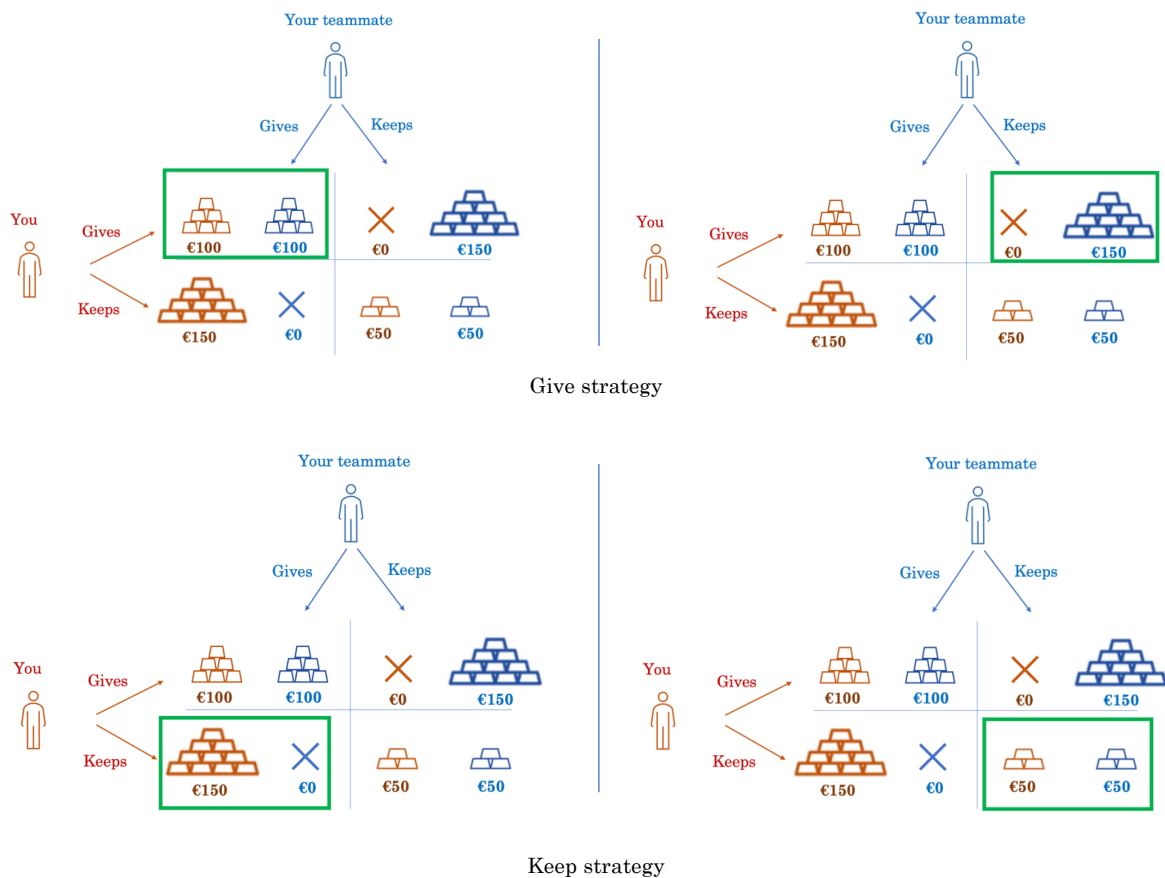
<sup>5</sup> It will be done at the beginning of February.

<sup>6</sup> Members of the French interprofessional organization Val'hor are retailers, producers and landscapers.

<sup>7</sup> InVivo group, for example, owns the Gamm Vert, Jardiland, Delbard & associés and Jardineries du Terroir brands, which represent 50% of the specialized distribution. There are only 4 other left in total: Botanic, Truffaut, Jardin et Saisons, Espace Émeraude.

behavior is therefore not relevant in our experiment. That's why we circulated the survey only to companies producing plants (producers) or landscaping services (landscapers). The survey was disseminated to a list of contact persons built by the authors, based on search on the websites of official organizations, trade shows, and companies with labels<sup>8</sup> in the horticultural sector. In total, 1 046 e-mails were sent to producers and landscapers in late December and early January. A reminder was sent 4 days after the first e-mail. At the same time, our call for participation was also relayed by professional organizations. We also published this call on the social network LinkedIn.

Figure 1b. Image sent before the decision is made



## 4. Results

### 4.1 Sample description

Out of a total of 145 responses from the first phase of the survey, we received 61 completed answers (both part 1 and 5 daily decisions in part 2): 27 landscapers and 34 producers. Respondents had no difficulty to self-declare their type

<sup>8</sup> official organizations such as UNEP, FFP, or members of the BHR, trade shows such as the international SIVAL show, the Salon du Végétal, Paysalia, and the labels are horticultural labels such as « Fleur de France » and « Plante Bleue ».

(landscapers or producers)<sup>9</sup>. Despite the challenge of recruiting professionals to take part in a field experiment (Weigel et al., 2021), the answer rate is 13.9% for part 1 and 4.8% for both parts.

Table 1 shows the general description of our sample. The average age is 44, with a median of 45.5 (47 for producers and 42,5 for landscapers), which is slightly younger than the population<sup>10</sup> (44 years old for landscapers and 52 for horticultural producers). Gender repartition is significantly different in the two subgroups, which is in-line with the population. Our sample is more educated than the population, with 93% of respondents who have received higher education (40% in the population). The size of the companies sampled reflects the population, with higher frequency of micro-company structure with less than 5 employees.

**Table 1.** Descriptive variables

| %                                   | Producers<br>(N <sup>a</sup> =34) | Landscapers<br>(N=27) | Total<br>(N=61) |
|-------------------------------------|-----------------------------------|-----------------------|-----------------|
| <b>Gender:</b> Men                  | 82,4                              | 55,6                  | 70,5            |
| <b>Age<sup>11</sup>:</b>            |                                   |                       |                 |
| 58-76                               | 11,8                              | 11,1                  | 11,5            |
| 43-57                               | 55,9                              | 37,0                  | 47,5            |
| 27-42                               | 32,4                              | 51,9                  | 41,0            |
| <b>Education:</b>                   |                                   |                       |                 |
| Youth Training/BTEC                 | 2,9                               | 0,0                   | 1,6             |
| High-School Diploma/Degree          | 2,9                               | 7,4                   | 4,9             |
| Bachelor's Degree                   | 50,0                              | 25,9                  | 39,3            |
| Master's Degree                     | 44,1                              | 63,0                  | 52,5            |
| Doctoral Degree                     | 0,0                               | 3,7                   | 1,6             |
| <b>Activity:</b>                    |                                   |                       |                 |
| business owner                      | 88,2                              | 77,8                  | 83,6            |
| employee                            | 11,8                              | 22,2                  | 16,4            |
| other                               | 0,0                               | 0,0                   | 0,0             |
| <b>Company type:</b>                |                                   |                       |                 |
| private company                     | 91,2                              | 96,3                  | 93,4            |
| association                         | 2,9                               | 3,7                   | 3,3             |
| other                               | 5,9                               | 0,0                   | 3,3             |
| <b>Company Size (FTE):</b>          |                                   |                       |                 |
| Micro enterprise $\leq 5$           | 38,2                              | 74,1                  | 54,1            |
| Small enterprise $>5$ and $\leq 50$ | 41,2                              | 25,9                  | 34,4            |
| Other $>50$                         | 20,6                              | 0,0                   | 11,5            |

<sup>a</sup> N indicates the number of subjects

<sup>9</sup> To be able to play, the participants gave their e-mail address. This allowed us to know the identity of their company and to quickly check their sector vs. their statement.

<sup>10</sup> The national data were collected on different professional sites

<sup>11</sup> The age distribution corresponds to the generation distribution

## 4.2 Results

In this section, we present experimental results to test our 3 hypotheses.

### Preferences for environmental concerns and collective action

The first part of the survey is a questionnaire to measure general environmental concerns. Defined by Franzen & Vogl (2013), an environmental concern is the fact for an individual of having insight both the conviction that man endangers the natural environment, and at the same time the willingness to protect nature. It introduces individuals to the issue of biodiversity, and finally, positions them to participate in a collective action, such as the week of flowers for the bees. We measure here the attitudes by the 5-point Likert scale. Table 2 shows that there is no central tendency bias. More than 95% of the individuals declare to feel concerned by environmental issues in general, the loss of biodiversity, and lastly the disappearance of pollinating insects.

**Table 2. Degree of environmental concern**

| % sensitive                          | Producers<br>(N <sup>†</sup> =34) | Landscapers<br>(N=27) | Total<br>(N=61) |
|--------------------------------------|-----------------------------------|-----------------------|-----------------|
| Environmental issues                 | 97,1                              | 92,6                  | 95,1            |
| Loss of biodiversity                 | 94,1                              | 96,3                  | 95,1            |
| Disappearance of pollinating insects | 100,0                             | 96,3                  | 98,4            |

<sup>†</sup> N indicates the number of subjects

Despite declared concern for the environment, biodiversity and pollinating insects, participants of respondents to the Flowers for Bees event are low (1 200 participants in 2022). Table 3 confirms the characteristics of the participants on a national level, as 35% of the participants are producers and only 5% are landscape sector. Landscapers are less familiar with this animation than horticulturists, while they reported a higher degree of concern for biodiversity.

**Table 3. Know and participate in the animation of flowers for the bees' week**

| %                    | Producers<br>(N <sup>a</sup> =34) | Landscapers<br>(N=27) | Total<br>(N=61) |
|----------------------|-----------------------------------|-----------------------|-----------------|
| Yes                  | 70,6                              | 11,1                  | 44,3            |
| <b>Participation</b> | <b>N=24</b>                       | <b>N=3</b>            | <b>N=27</b>     |
| 2017                 | 16,7                              | 33,3                  | 18,5            |
| 2018                 | 16,7                              | 33,3                  | 18,5            |
| 2019                 | 25,0                              | 33,3                  | 25,9            |
| 2020                 | 29,2                              | 33,3                  | 29,6            |
| 2021                 | 41,7                              | 66,7                  | 44,4            |
| 2022                 | 29,2                              | 33,3                  | 29,6            |

<sup>a</sup> N indicates the number of subjects

The third group of questions puts individuals back on the motivations and barriers of a collective action. A proposal of nine items was put forward. These items emerged during individual interviews with professionals in the sector since January 2022. Again, there is no central tendency bias. Aside from the item “small number of participants”<sup>12</sup> and “financial contribution of each participant”, individuals<sup>13</sup>, respondents agreed on the reasons likely to contribute to the success of a collective action, and there are no significant differences between growers and landscapers.

In the comments that came back from the survey (both from the landscapers and the producers), the conviction to work for the common good is also mentioned as a success factor of a collective action, but unfortunately the objective is often diverted to personal profit, which makes the action ineffective (the reference to greenwashing has been mentioned). Respondents also mentioned the importance of clearly defined objectives for a collective action to be successful. Moreover, in roles and tasks allocation, complementarity is to be preferred to similarity, perceived as a source of competition.

**Table 4.** Key factors for the success of a collective action by the professionals of the sector

| % yes <sup>a</sup>                                 | Producers<br>(N=34) | Landscapers<br>(N=27) | Total<br>(N=61) |
|----------------------------------------------------|---------------------|-----------------------|-----------------|
| Inter-knowledge of the stakeholders                | 88,2                | 74,1                  | 82,0            |
| Sharing a common goal, clearly defined objective   | 100,0               | 92,6                  | 96,7            |
| Complementarity in the tasks and know-how          | 94,1                | 96,3                  | 95,1            |
| Equitable time allocation between the participants | 85,3                | 85,2                  | 85,2            |
| Financial contribution of each participant         | 61,8                | 48,1                  | 55,7            |
| Getting external funding                           | 91,2                | 77,8                  | 85,2            |
| Seeing the effects of the action quickly           | 79,4                | 88,9                  | 83,6            |
| Small number of participants                       | 17,6                | 14,8                  | 16,4            |
| Large number of participants                       | 88,2                | 74,1                  | 82,0            |

<sup>a</sup>Measures were made on a 5-point Likert scale. The percentage of yes corresponds to “definitely” and “somewhat yes”

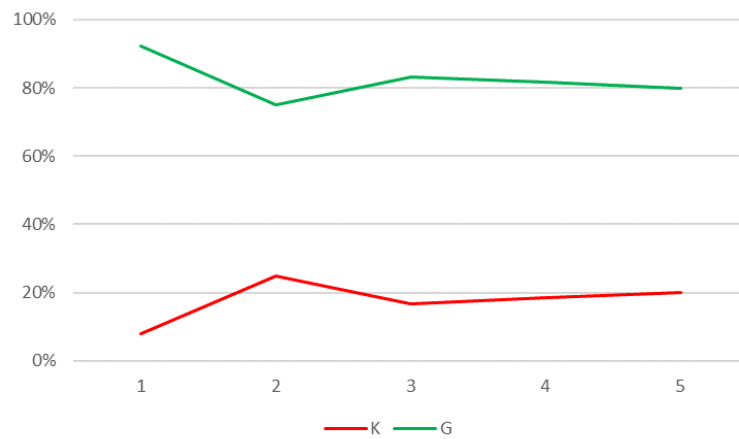
### Prisoner's dilemma repeated 5 times

First, on all decisions made, the cooperation rate (choice to give) is high (around 80%). This rate remains stable over the five days, we do not observe an end of game effect (Figure 2).

<sup>12</sup> The issue of size must be placed in the context of horticultural and landscape firms. The results here show that a large number can be a key factor. This large number is in the context of horticultural and landscape businesses, which are often microenterprises. What is defined as a large number may only be a reasonable number. The interviews have shown that in reality, cooperative actions beyond a dozen companies often end in failure and members revert to minimal configurations of 2 to 3 or prefer to remain alone.

<sup>13</sup> Out of the 61 players, only 2 have participated in individual interviews conducted since January 2022.

**Figure 2.** Evolution of the rate of cooperation (ie, give G; K for keep)



The analysis of the results of the 5 days can be conducted in two steps. The first day, all participants played without knowing the other player's decisions. They only knew whether they are matched with someone from their sector or not. From the 2nd to the 5th day, before taking their decision, each participant learned what the other player played in the previous day.

**Table 5.** Day 1: decision/what they think the other will do

| %                | P-P<br>(N=15) | L-L<br>(N=9) | P-L<br>(N=34) | Total<br>(N=58 <sup>b</sup> ) |
|------------------|---------------|--------------|---------------|-------------------------------|
| K/K <sup>a</sup> | 6,7           |              | 11,8          | 8,6                           |
| K/?              |               |              | 8,8           | 5,2                           |
| G/G              | 80,0          | 77,8         | 58,8          | 67,2                          |
| G/?              | 13,3          | 22,2         | 20,6          | 19,0                          |

<sup>a</sup> K for keep strategy, G for give strategy and “?” for don't know.

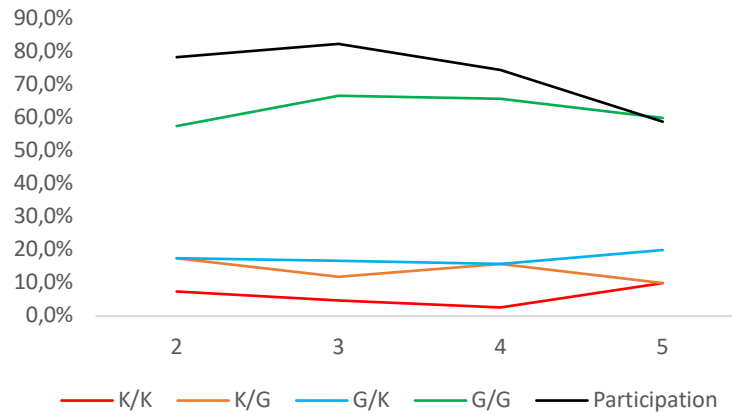
<sup>b</sup> the decisions automatically made by the robot program when the players did not play were removed

The cooperation rate in the first day is very high, despite the fact that 22% declare that they do not know how the other player will react. For the P-L group, the level of cooperation is lower than the P-P and L-L groups. This may imply an in-group favouritism effect.

For the rest of the game, the decisions from the 2nd to the 5th step allow to analyse the decisions conditioned by the behaviour of the other player in the previous step. 4 conditioned strategies are possible: K/K, K/G, G/K and G/G. For example, G/K means to give knowing that the other player kept in the previous step. Figure 3 shows the evolution of these 4 strategies from Tuesday (day 2) to Friday (day 5). Of the 61 subjects who played on the first day, we lost about 20% of subjects on the next two days and observed a sharp decline in participation on the last two days. With busy professionals, it is difficult to keep them active over 5 days. Nevertheless, the results are clear. The G/G strategy is clearly the most observed, with about 60% of the cases. The second most observed strategy is the

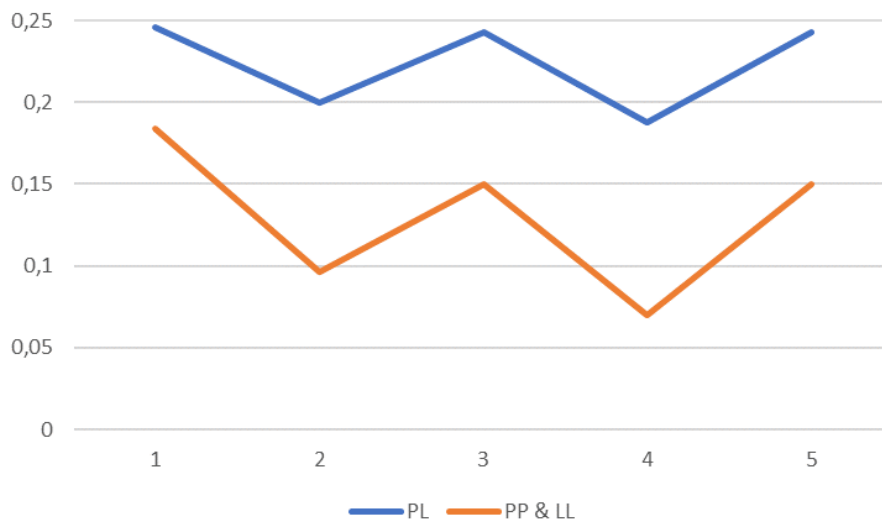
most cooperative behaviour: giving while the other has previously kept (G/K). Conversely, the least cooperative strategy, keeping when the other has given (K/G) is rare. The end-of-game effect on day 5 in our experiment is not observed.

**Figure 3.** Rates of the conditioned decisions and the participation (days 2-5).



The figure 4 illustrates the evolution of the defection decisions (keeping) over the 5 days. The tendencies over the in-group (PP and LL) and the out-group (PL) are very similar but the rate of defection is always smaller in the in-group. Over the 5 days, this rate is in average respectively 22.4% and 13%. The first one is significantly higher ( $z = 2.18, p < 0.01$ ): there is an in-group effect in favour of the cooperation and our hypothesis H1 is validated. Mitani (2022) obtained the same result with Japanese villagers, allocated randomly to an in-community or out-community treatment.

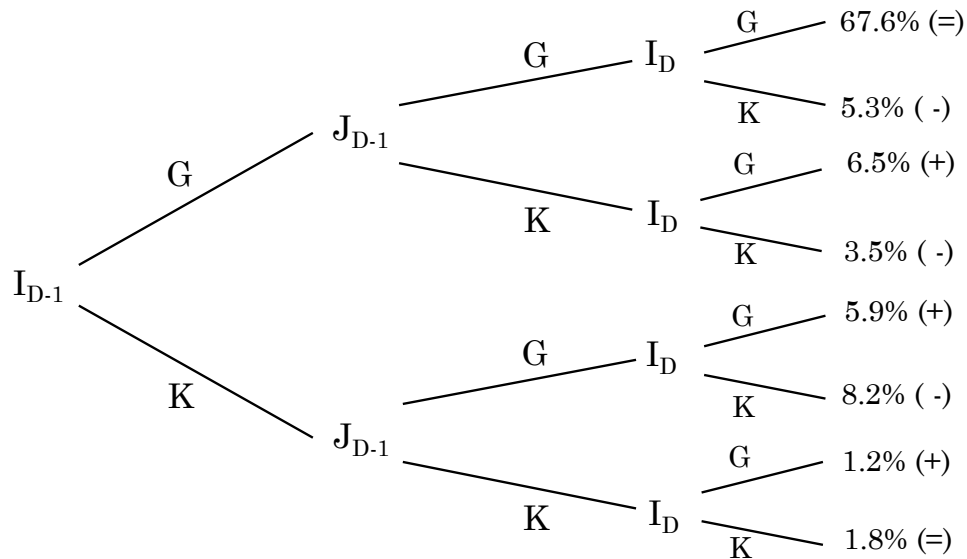
**Figure 4.** Rate of keeping (K) decisions over the 5 days.



In total over the 5 days, the cooperation rate is very high as 59.3% (G/G strategy) both gave during the 5 days, while 8.5% continue to give in day D, knowing that the other player kept in day D-1.

We note Z/X-Y for the decision X of a player I on day D-1, Y for the decision of the partner J on day D-1 and then the decision Z of the player I on day D. The figure 5 summarizes all the possible paths. There are 8 possible profiles. 2 are simply the continuity (=) and could be considered as neutral (K/K-K and G/G-G). 3 are positive (+) by improving the cooperation: G/G-K, G/K-G and G/K-K. The last 3 are negative (-) with more defection: K/G-G, K/G-K and K/K-G. The cooperation rate is therefore very high, and respondents are willing to maintain cooperation, regardless of the decision made by the other in the previous round.

**Figure 5.** Rate (%) of each conditional decision over the days from 2 to 5 (N=170)



When we compare the in-group and the out-group, we observe 10 positive evolutions and 15 negative evolutions in the in-group, and 16 positive evolutions and 12 negative evolutions in the out-group. We therefore reject H2 since we observe more sustained cooperation out-group.

**Table 6.** Dependent variable: to keep each day – Binary Probit  
Explained by socio-demographic characteristics and attitudes towards the environment

| $\gamma_i$   | Day 1            | Day 2             | Day 3             | Day 4               | Day 5               |
|--------------|------------------|-------------------|-------------------|---------------------|---------------------|
| constant     | 1.183<br>(2.127) | 2.794*<br>(1.657) | -1.410<br>(2.641) | -2.909<br>(2.290)   | -3.129<br>(2.459)   |
| Man          | 0,923<br>(0,813) | 0,618<br>(0,600)  | 0,244<br>(0,668)  | 0,296<br>(0,755)    | 0,186<br>(0,659)    |
| Age, in year | 0,010<br>(0,030) | 0,005<br>(0,027)  | 0,016<br>(0,029)  | 0,03832*<br>(0,023) | 0,04743*<br>(0,025) |

|                                    |                      |                     |                      |                       |                   |
|------------------------------------|----------------------|---------------------|----------------------|-----------------------|-------------------|
| More than BA                       | 1,428**<br>(0,689)   | 1,142**<br>(0,562)  |                      | 0,336<br>(0,585)      | -0,425<br>(0,571) |
| More than Master                   | -0,792<br>(0,709)    | -0,510<br>(0,665)   | -0,518<br>(0,604)    | -0,673<br>(0,648)     | -0,174<br>(0,615) |
| Producer                           | -0,356<br>(0,522)    | -0,254<br>(0,486)   | -0,567<br>(0,450)    | 0,501<br>(0,535)      | 0,034<br>(0,491)  |
| Company Size                       | 0,007<br>(0,006)     | 0,011<br>(0,009)    | 0,01245**<br>(0,005) | 0,01612***<br>(0,006) | 0,010<br>(0,008)  |
| Degree Environment Concern         | 0,761<br>(0,612)     | -0,280<br>(0,630)   | -0,598<br>(0,512)    | -0,281<br>(0,468)     | -0,507<br>(0,571) |
| Degree Biodiversity Concern...     | -1,062*<br>(0,557)   | -0,007<br>(0,580)   | 0,720<br>(0,552)     | 1,929**<br>(0,781)    | 0,180<br>(0,635)  |
| Degree pollinating insects Concern | -0,747<br>(0,609)    | -1,081**<br>(0,505) | -0,311<br>(0,593)    | -1,867**<br>(0,776)   | 0,304<br>(0,636)  |
| Play with the same sector          | -1,678***<br>(0,467) | -0,456<br>(0,473)   | 0,504<br>(0,484)     | -0,194<br>(0,598)     | 0,496<br>(0,467)  |
| n                                  | 58                   | 48                  | 53                   | 51                    | 47                |
| R2                                 | 0,347                | 0,230               | 0,181                | 0,336                 | 0,135             |
| lnL                                | -15.21               | -18.92              | -16.94               | -14.71                | -21.03            |

\*\*\*, \*\* and \*: significance at 1%, 5% and 10% levels  
standard errors in parentheses. For the Probit models, the R2 is the pseudo-R2 of McFadden  
For each variable, the value is 1 if it is the situation described in the table, and 0 otherwise.  
For each decision, keep =1 and give=0

There is a very significant correlation between the decision to give or keep and the fact of playing with a player from his sector, for the day 1. This effect disappears afterwards. On the other hand, we can see that the degree of concern for pollinating insects and biodiversity emerge over the 4 days of play. Concerning the size of the company, for the 3rd and 4th day, the more the size of the company increases, the more the individuals keep.

## 5. Discussion and concluding remarks

We provide the results of a field experiment on cooperation using professionals of the horticultural sector as participants. We focus on cooperation towards a collective action that aims at promoting plants beneficial to pollinating insects, called “Flowers for bees’ week”. We study the determinants of cooperation through a dual approach: a measure of stated preferences towards collective action and the environment, and a decontextualized strategic game played over five days. While horizontal and vertical cooperation in the sector is limited, we observe extremely high rate of cooperation in the field experiment: 74.1% of players gave over the 5 days regardless of the other player's decision. Cooperation was significantly higher in the in-group treatment than in the out-group treatment. This suggests that group identity can be a key factor of success for collective action. But to activate these levers, one need to make sure that professionals can identify themselves to a group. In-groups are groups that we identify with, while out-

groups are groups that we do not identify with Tajfel et al. (1971). To make group identity more salient in the game, we ask respondents to self-declare their type in Part 1 (Landscape/Producer/Other). It has helped respondents to identify themselves to this sub-group. Once a person considers herself to belong to a group, she derives self-esteem from this group membership and adopts behaviors consistent with the stereotypes associated with the group identity (Chen & Li (2009). They compare their group to other groups, creating a bias in favor of the group to which they belong. Group identity allows the other to be seen as a partner (Jiang & Li, 2019), and makes individuals taking decisions as members of a team, rather than individual profit-maximizing ones (Tajfel et al., 1971). Alternatively, one could have made the identity “horticultural sector” more salient, rather than sub-group identities. This may have triggered more cooperation between landscapers and producers.

This idea implies that. Instead of maximizing his individual gain, he interprets a game or situation as collective (Elsenbroich & Payette, 2020). Belonging to a group blurs the boundaries between self and others and leads group members to contribute more to the well-being of the group, at the expense of their own utility (Rabinovich & Morton, 2011). The team theory of reasoning is positioned as an alternative to the traditional maximization of individual utility and helps explain cooperative behavior in social dilemma situations.

The proportion of cooperative decisions was stable over the 5 days, with no end-of-game effect. On the contrary, previous evidence has shown that cooperation drops over time. People switch to free-riding when they observe selfish behavior in their group or towards the end of the game, when no more interactions are foreseen (Axelrod, 1984; Dal Bó, 2005; Gächter & Thoni, 2005; Guido et al., 2019; Keser & Van Winden, 2000). Here, respondents are willing to maintain cooperation, independently from the decision taken by the other in the previous round (which has no impact). This result is surprising given the importance of history in French horticulture, which dates back to the early 1700s. Horticulturists' lineage is important (Gaignard, 2016). In family companies, with successive generations of horticulturists, past events are very present. Cooperation failures in the past still impact perception of the likely success of collective actions.

In this context, a burning question is how to initiate cooperation. In the game, cooperation in day 1 is higher for those believing that the other will cooperate as well. Yet, professionals from the horticultural sector know that cooperation is overall low, but it did not influence their beliefs in the game. Communication could help in shaping beliefs, to move away from the idea that professionals of the horticultural sector do not cooperate. To that end, the fact that professionals from both sectors share the same views on what constitutes collective action and how to achieve cooperation is instrumental to triggering more optimistic beliefs.

Lastly, we found significant correlation between stated attitudes towards biodiversity and cooperative decisions in the game. This suggests acceptable external validity of the game, despite the artefactual format.

One obvious limitation of our study is the number of participants. Of the 145 responses from the first phase, only 61 participants returned to play the second phase. One person came forward to explain that he did not understand the point of the games and the relationship with the first phase, and therefore preferred to stop the game after the fourth day, knowing that there was only one day left. Recruiting participants from the professional world is complex (Weigel et al., 2021), especially since our game mobilizes them over 5 days in a row, but a larger sample size can contribute greatly to the robustness of the results found.

One can also question the relevance of a 5-days repetition to measure sustainability of cooperation. Our framework, although simplistic, reflects real-life: individuals engage in a collective action, then return to their private business, and only to return to it another day. Having players come back every day thus reflects what happens in real life. Participation to a collective action is a commitment, which is added to all the daily tasks.

To go further into the understanding of the drivers of initial cooperation, one could play another game, the volunteer dilemma (Diekmann, 1985; Franzen, 1995; Rapoport, 1988; Villiger et al., 2022), with the same professionals. This is a variant of the prisoner's dilemma, still with two choices, but played with N players. If at least one of the players agrees voluntarily to receive a lower profit, the others win the common pot. This would allow to know the rate of individuals who would be likely to accept to initiate the cooperation at the expense of their own outcome.

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# Appendix

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## Appendix 1: Questionnaire



This questionnaire on LimeSurvey was run in French. It is translated into English here for the appendix.

### Survey on the plant sector – University of Angers

We are researchers working for the University of Angers. Our study is completely anonymous and is conducted without commercial or political purposes.

#### **Expected answers**

We expect answers from people in charge of strategic decisions in horticultural or landscaping companies.

#### **Data management**

This study is anonymous. Neither your name nor your company's name will be asked.

In accordance with the principles of open science, and in compliance with the General Data Protection Regulation, the anonymized data will be archived and made available for scientific use.

#### **Duration**

The survey lasts a maximum of 10 minutes. You can stop at any time and resume later, by clicking on the same link.

To return to the questions on the previous page, click on “previous” at the bottom left of each page but do not go back on the browser, otherwise your answers will not be recorded.

In addition to this short questionnaire, we offer you an online game with other horticulturists and landscapers.

Your answers will allow us to make useful recommendations to your industry.

This game will take you a maximum of 2 minutes per day from Monday January 16, 2023, to Friday January 20, 2023.

On each of these days, you can play at any time of the day or night!

#### **To thank you**

For each complete answer, you will be entered into a draw that could make you win up to €150, depending on your answers in the game.

#### **Contact**

For any question: [ngoc-thao.noet@etud.univ-angers.fr](mailto:ngoc-thao.noet@etud.univ-angers.fr)

There are 28 questions in this questionnaire.

## 1 Consent

### 1.1 Consent \*

Please select a response below

Please select only one of the following:

- I confirm that I have read and understand the above information. I am at least 18 years old, and I give my consent to participate in this study.
- I do not give my consent to participate in this study.

## 2 Your profile

### 2.1 You are: \*

Please select only one of the following:

- a man
- a woman

### 2.2 Your year of birth:

\* Please write your answer here:

### 2.3 You are : \*

Please select only one of the following:

- Manager
- Employee
- Other

### 2.4 What is your education level? \*

Please select only one of the following:

- No diploma
- 9th Grade
- Vocational certificate obtained 2 years after the 9th grade
- High-School Diploma/Degree
- 12th Grade / Associate's degree
- Bachelor's degree
- Master's degree
- One-year degree before postgraduate studies
- PhD
- Other

### 2.5 In which sector do you work? \*

Please select only one of the following:

- Horticultural production
- Landscape sector
- Other

**Thank you for your participation. Our questionnaire is only for horticultural producers and landscape professionals.**

Answer this question only if the following conditions are met: The answer was 'Other' to question '6 [Q006]' (In which sector do you work?)

#### 2.6 In what type of structure do you work? \*

Answer this question only if the following conditions are met:

The answer was NOT 'Other' in question '6 [Q006]' (In which sector do you work?)

Please select only one of the following:

- Private company
- Association
- Other

#### 2.7 What is your job? \*

Answer this question only if the following conditions are met:

The answer was 'Horticultural production' in question '6 [Q006]' (In which sector do you work?)

Please select only one of the following:

- Nurseryman
- Horticulturist
- Cut flower grower
- Mixed category grower
- Other

#### 2.8 What is your job? \*

Answer this question only if the following conditions are met: The answer was 'Landscape industry' in question '6 [Q006]' (What industry do you work in? )

Please select only one of the following:

- Landscape contractor
- Landscape designer (or similar)
- Other

#### 2.9 Did you participate in our survey (University of Angers - Cooperation Sector) in January 2022? \*

Answer this question only if the following conditions are met: The answer was NOT 'Other' in question '6 [Q006]' (In which sector do you work?)

Please select only one of the following:

- Yes
- No

#### 2.10 Did you participate in our survey (University of Angers - Cooperation Sector) in October 2022? \*

Answer this question only if the following conditions are met: The answer was NOT 'Other' in question '6 [Q006]' (In which sector do you work?)

Please select only one of the following:

- Yes

- No

### 2.11 Approximately how many people (employees, non-employees, or FTEs) work in the company at all locations? \*

Answer this question only if the following conditions are met:

The answer was NOT 'Other' in question '6 [Q006]' (In which sector do you work?)

Please write your answer here:

## 3 Your opinion on an action implemented by the sector

Please answer these questions as if you were in a professional context.

### 3.1 Overall, how sensitive are you to environmental issues (e.g., climate change, pollution, water scarcity, etc.)?

Answer this question only if the following conditions are met: The answer was NOT 'Other' in question '6 [Q006]' (In which sector do you work?)

Please select only one of the following:

- Totally sensitive
- Somewhat sensitive
- Neither sensitive nor insensitive
- Somewhat insensitive
- Totally insensitive

### 3.2 Overall, how sensitive are you to the loss of biodiversity? \*

Answer this question only if the following conditions are met: The answer was NOT 'Other' in question '6 [Q006]' (In what sector do you work?)

Please select only one of the following:

- Totally sensitive
- Somewhat sensitive
- Neither sensitive nor insensitive
- Somewhat insensitive
- Totally insensitive

### 3.3 Overall, how sensitive are you to the disappearance of pollinating insects?

Answer this question only if the following conditions are met: The answer was NOT 'Other' in question '6 [Q006]' (In what sector do you work?)

Please select only one of the following:

- Totally sensitive
- Somewhat sensitive
- Neither sensitive nor insensitive
- Somewhat insensitive
- Totally insensitive

### 3.4 Overall, how sensitive are you to the disappearance of pollinating insects?

Answer this question only if the following conditions are met: The answer was NOT 'Other' in question '6 [Q006]' (What industry do you work in?)

Please select only one of the following:

- Yes
- No

### 3.5 Are you familiar with Flower Week for Bees?

Answer this question only if the following conditions are met:

The answer was NOT 'Other' in question '6 [Q006]' (What industry do you work in?)

Please select only one of the following:

- Yes
- No

3.6 The "Flowers for Bees Week" is a citizen awareness week conducted by Val'hor in partnership with the French Observatory of Apidology. By allowing the general public to discover the role of melliferous plants and to buy some, this collective action contributes to the fight against the disappearance of pollinating insects, and to the preservation of biodiversity. During a week in June, animations highlight the honey plants and their role for the biodiversity.

Answer this question only if the following conditions are met: The answer was 'No' to question '17 [Q106]' (Do you know about the week of flowers for bees?)

### 3.7 Have you ever participated in Flowers for Bees Week?

Answer this question only if the following conditions are met: The answer was 'Yes' to question '17 [Q106]' (Are you aware of Flower Week for Bees?)

Choose the appropriate answer for each item:

Yes    No

2022  
2021  
2020  
2019  
2018  
2017

## 4 Your opinion on a collective action

4.1 Do you think that a collective action such as Flowers for Bees Week can improve the general public's recognition of the role of plants in the preservation of pollinating bees? \*

Answer this question only if the following conditions are met: The answer was NOT 'Other' in question '6 [Q006]' (What industry do you work in?)

Please select only one of the following:

- Yes
- No

4.2 Do you think that a collective action such as Flowers for Bees Week can help increase sales of honey plants? \*

Answer this question only if the following conditions are met: The answer was NOT 'Other' in question '6 [Q006]' (What industry do you work in?)

Please select only one of the following:

- Yes
- No

4.3 Are you planning to participate in Flowers for Bees Week 2023? \*

Answer this question only if the following conditions are met: The answer was NOT 'Other' in question '6 [Q006]' (What industry do you work in?)

Please select only one of the following:

- Yes, probably
- Yes, maybe
- No
- Don't know

4.4 To what extent do you think each of these factors can contribute to successful collective action in the plant sector? \*

Answer this question only if the following conditions are met: The answer was NOT 'Other' in question '6 [Q006]' (What industry do you work in?)

Please select only one of the following:

Choose the appropriate response for each item:

|                                                    | Definitely | Somewhat<br>yes | Somewhat<br>no | Not<br>at<br>all | Don't<br>know |
|----------------------------------------------------|------------|-----------------|----------------|------------------|---------------|
| Inter-knowledge of the stakeholders                |            |                 |                |                  |               |
| Sharing a common goal, clearly defined objective   |            |                 |                |                  |               |
| Complementarity in the tasks and know-how          |            |                 |                |                  |               |
| Equitable time allocation between the participants |            |                 |                |                  |               |
| Financial contribution of each participant         |            |                 |                |                  |               |
| Getting external funding                           |            |                 |                |                  |               |
| Seeing the effects of the action quickly           |            |                 |                |                  |               |
| Small number of participants                       |            |                 |                |                  |               |
| Large number of participants                       |            |                 |                |                  |               |

If you wish to specify other factors of success of a collective action, you can use the space below.

Answer this question only if the following conditions are met: The answer was NOT 'Other' in question '6 [Q006]' (What industry do you work in?)

Please select only one of the following:

Please write your answer here:

#### 4.5 \*

**We will now invite you to an online game with other producers and landscapers in the next few days.**

**This game will take you a maximum of 2 minutes per day from Monday, January 16, 2023, to Friday, January 20, 2023.**

**Each day, you can play at any time of the day or night!**

**For each complete answer, that is to say 5 answers sent during these 5 days, you will be able to participate in a draw which could make you win up to €150, according to your answers in the game.**

Please indicate here your email address to receive the instructions of the game.

This information will then be destroyed, and the data processed anonymously.

Answer this question only if the following conditions are met: The answer was NOT 'Other' in question '6 [Q006]' (What industry do you work in?)

Please select only one of the following:

Please write your answer here:

## 5 Your comment

### 5.1 Would you like to receive the results of this study by e-mail in 2023? \*

Please select only one of the following:

- Yes
- No

### 5.2 Please specify your e-mail address.

Answer this question only if the following conditions are met: The answer was NOT 'Other' in question '6 [Q006]' (What industry do you work in?)

Please select only one of the following:

Please write your answer here:

**If you have any comments, please feel free to use the space below.**

Please write your answer here:

Thank you for your participation.

Send your questionnaire.

Thank you for filling out this questionnaire

## Appendix 2: The instructions sent to each participant for the prisoner's dilemma - 5 days

Figure 6. The instructions

### Memento for the strategic game over 5 days, from January 16 to 20

You are 64 from the landscaping sector and 68 from the horticultural sector.

All games are played 5 times for 2, always with the same player.

You will be in one of the following three groups:

Group 1: 34 from the horticultural sector playing as a horticultural/horticultural pair

Group 2: 34 from the horticultural sector and 34 from the landscape sector playing as a horticultural/landscape pair

Group 3: 30 from the landscape sector playing as a landscape/landscape pair.

At the end of the game, 4 pairs of players out of 66 will be drawn, under the control of our financial manager: you therefore have a 6.06% probability of winning prizes. The decision of one of the 5 days will be drawn to determine the value of the prizes, which will range from €50 to €150, in Illicado vouchers.

You will play on January 16, 17, 18, 19 and 20 between 2 a.m. and 11 p.m. Each time, it will take a maximum of 2 minutes, by clicking on the following link <https://abeille49.herokuapp.com/room/Abeille>  
For any information, contact by email [vegetal@univ-angers.fr](mailto:vegetal@univ-angers.fr)

## Appendix 3: What participants see when they log on to oTree

1.

### Bienvenue

Veuillez saisir votre label de participant

Suivant

Le jeu peut commencer

Suivant

2.

### Jeux stratégiques

Voici le temps qu'il vous reste en minute avant ce soir 22h00 pour répondre : 473:10

### Quatrième Tour



Vous rejouez pour ce quatrième jour le même jeu, avec ce même joueur d'un autre secteur

Vous aurez à nouveau 50€, sous condition d'y participer.

Les règles du jeu sont les mêmes.

Chacun garde ou donne à l'autre les 50€, sachant que les sommes données sont multipliées par 2. Donc, si vous gardez, vous avez 50€, et si vous donnez, l'autre personne a 100€.

Si les 2 donnent ce montant, les 2 ont chacun 100€.

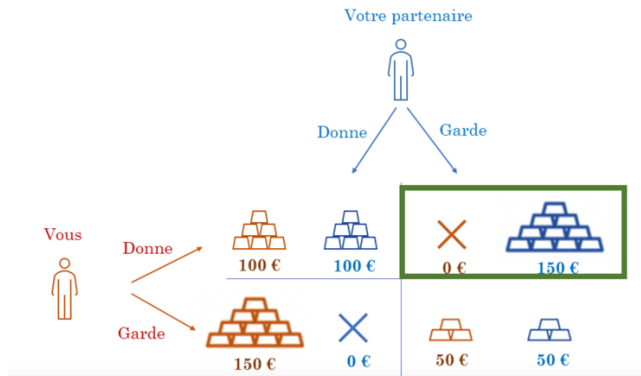
Si les 2 gardent ce montant, les 2 ont chacun 50€.

Sinon, celui qui garde ce montant a 150€ et celui qui donne ce montant a 0€.

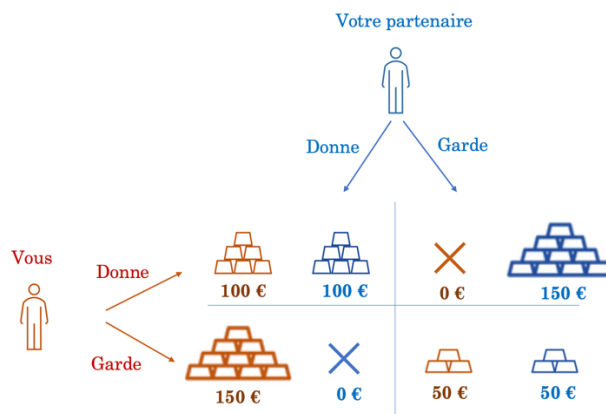
4.

Voici ce qui s'est passé hier :

Au tour 1 vous remportez : 0,00 €



5.



Que faites-vous ?

- ☐ Garder les 50€  
☐ Donner les 50€

Vous êtes au tour : 4

Suivant